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UNITED STATES UTILITY PATENT APPLICATION

FOR

AN IMPROVED PLENUM AND DIFFUSER FOR HEATING, VENTILATING AND AIR CONDITIONING APPLICATIONS

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Paul H. Johnson
Typed Name

Paul H. Johnson
Signature

{340620;2}

AN IMPROVED PLENUM AND DIFFUSER FOR HEATING, VENTILATING AND AIR CONDITIONING APPLICATIONS

REFERENCE TO PENDING APPLICATIONS

This Application is not based upon any pending domestic or international United States patent application.

REFERENCE TO MICROFICHE APPENDIX

This application is not referenced in any microfiche appendix.

FIELD OF THE INVENTION

The invention herein relates to the field of heating, ventilation and air conditioning distribution systems and particularly to a plenum and a diffuser for use therewith.

BACKGROUND OF THE INVENTION

Most buildings in the United States and other industrialized countries of the world at the present time have built-in heating, ventilating and air conditioning systems. Whether such buildings are homes, offices, schools, distribution facilities, warehouses, manufacturing facilities or the like, most buildings have some facilities for circulating air. Usually the circulated air is recirculated and passes through a system by which the air is either heated, cooled or filtered so as to provide a desirable environment in which to live or work.

To distribute air from a forced air system into a room, a common practice is to introduce the forced air through a ceiling vent. A typical ceiling vent is designed not only to provide an opening through which air passes into a room but also to aid in distributing or diffusing the air in a room. Another desired aspect of a ceiling vent is to provide an improved appearance -- that is, to provide a way for air to enter a room that is other than simply a hole in the ceiling with which an air duct connects.

A common means of improving the comfort of a room is by the use of a ceiling fan. Ceiling fans are employed throughout the world and typically consist of a motor having a vertical shaft attached to a hub from which a plurality of blades radially extend. The typical ceiling fan has relatively large blades and the fan is designed to turn the blades at relatively low rpms so as to achieve good distribution of air without producing excessive noise. Ceiling fans are typically mounted so that the motor is in close proximity to the blades and the motor, having the blades extending therefrom, is suspended on a vertical rod. The upper end of the rod is affixed to a hanger by which the weight of the ceiling fan is supported and in an arrangement that provides for making electrical connection to the fan. An improved plenum and diffuser of this invention is particularly adaptable for use with a ceiling fan installation.

For background information relating to the invention herein, reference is specifically made to the following previously-issued United States Patents, each of which is incorporated herein by reference: (a) U. S. Patent No. 5,795,220 entitled, CEILING FAN WITH AN AIR DIFFUSER SYSTEM issued on August 18, 1988; and (b) U. S. Patent No. 6,030,287 entitled, SYSTEM FOR DISTRIBUTING AIR THROUGH A CEILING IN A ROOM issued on February 29, 2000. The U. S. and foreign patents cited in these two previously-issued patents may also be relevant.

For additional background information see the following previously-issued U. S. Patents:

Country	Patent Number	Issued	Title
US	3,125,943	March 24, 1964	Combined Lighting and Ventilating Fixture
US	3,299,797	January 24, 1967	Combined Air Diffuser and Lighting Fixture
US	3,701,895	October 31, 1972	Combined Lighting and Ventilating Fixture
US	3,909,589	September 30, 1975	Modular Heating, Lighting and Ventilating Unit
US	4,748,900	June 7, 1988	Ducted Ventilator
US	4,909,405	March 20, 1990	Interjoint Hanger Assembly and Attachable Support Box Therefor
US	5,795,220	August 18, 1998	Ceiling Fan With An Air Diffuser System
US	5,860,548	January 19, 1999	Junction Box For Ceiling Fan Support
US	6,030,287	February 29, 2000	System for Distributing Air Through a Ceiling in a Room
US	6,168,285	January 2, 2001	Universal, Light Fixture/Ceiling Fan Recessed Mounting Device
US	6,168,517	January 2, 2001	Recirculating Air Mixer and Fan With Lateral Air Flow

US	2001/0027086	[Pub. Date] October 4, 2001	Diffuser and Ceiling Fan Combination

BRIEF SUMMARY OF THE INVENTION

The invention herein is for use in a heating, ventilating and air conditioning system that is frequently referred to in the trade as a HVAC system. The invention herein is for distributing air through an opening in a horizontal ceiling. The invention includes an improved plenum in the form of a housing having a horizontal bottom. The housing further has a first and a second vertical end wall and a first and a second vertical sidewall. A sloped top is connected to the upper ends of each of the end walls and each of the sidewalls. The plenum housing bottom has a large diameter opening therein by which air is passed from the plenum through a ceiling and into the room with which the plenum is used.

The plenum housing first end is a substantially larger in area than the second end. The first and second sides are of equally dimensioned trapezoids. The sloped top of the plenum has an air inlet opening and a short length flange to telescopically receive an air distribution duct.

A telescopically extending hanger bar is positioned through small diameter openings in the opposed sidewalls and centrally over a large diameter opening in the plenum bottom.

A junction box is supported to the hanger bar, the junction box being centered over the large diameter bottom opening. The junction box provides means for supporting a light fixture or a ceiling fan to the plenum and provides a container for receiving electrical connections.

A flexible shielded electrical cable extends through an opening in one of the side and end walls and is connected to the junction box by which electrical energy is passed through the plenum to the junction box.

A diffuser is removably affixed to the housing bottom. The diffuser has an outer, circular circumferential edge and a central opening therein that exposes the junction box supported by the hanger within the plenum.

The diffuser has a plurality of integrally-formed radial veins that extend from adjacent the central opening to adjacent the circumferential edge.

The diffuser of this invention that is particularly adaptable for use with a plenum positioned above a ceiling by which air is passed through the ceiling into a room is a generally planar integral circular structure formed of a rigid material, such as sheet metal. The diffuser has an uninterrupted circular outer edge and a central opening dimension to accommodate an electrical junction box. Further, the diffuser has a pluralitively radially extending partially punched out fins that (after being punched) are each bent to extend at a common angle to the plane of the diffuser, each bent fin providing a radially extending air slot opening.

In a preferred arrangement, the diffuser is further defined by an integrally formed concentric circular forwardly protruding smudge ring. The integral smudge ring is thereby circumferentially positioned between the fins and the circular outer edge.

As an optional feature, a circular planar cap is provided that is removably attachable to the diffuser and dimensioned so that when attached, the central opening through the diffuser is closed but leaving the radially extending air slot openings unobstructed. An additional further feature includes a planar damper configured to removably cover a preselected number of the radial slot openings. The damper has integral retention means in engagement with the diffuser to provide a way of selectably regulating the total area of exposed radially extending air slot openings.

Further objects and features of the invention will be apparent upon reference to the following detailed description of the preferred embodiments and the claims, taken in conjunction with the attached drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an elevational partially cross-sectional view showing a plenum of this invention as utilized in a heating, ventilating or air conditioning system in a typical residential construction. The view shows a ceiling of a room in cross-section, the ceiling being supported between paralleled, spaced-apart rafters. The Figure shows a plenum chamber of this invention supported to the ceiling between joists and shows a ceiling fan extending downwardly from the plenum. Affixed to the bottom of the plenum is a diffuser of the present invention, the diffuser serving to provide means for passing air into the room and for distributing the air. The ceiling fan is shown in external elevational view.

FIG. 2 is an elevational view of the plenum chamber.

FIG. 3 is a bottom view as taken along the line 3-3 of FIG. 2. The plenum of FIGS. 2 and 3 is of the type specifically adapted to be mounted between wood ceiling joists as is typical in home construction in the United States and other areas where wood building materials are readily available.

FIG. 4 is an elevational side view of a plenum of this invention in an arrangement wherein the plenum is for use in a commercial type construction -- that is, wherein the plenum is not supported to ceiling joists, but instead wherein the plenum is hung from a support structure spaced above the ceiling. This may be referred to as a lay-in T-bar grid plenum.

FIG. 5 is a front view of the plenum as illustrated in FIG. 4.

FIG. 6 is a bottom plan view of the plenum as shown in FIGS. 2 and 3, and showing the installation of a unique diffuser of this invention. The diffuser provides for a plurality of radially extending air distribution slots. In the arrangement of FIG. 6, the diffuser is shown as equipped with a circular shield closing a center opening in the diffuser. Further, this view shows a

removable damper by which a preselected number of radially extending air slots are covered to thereby regulate the total cross-sectional area through which air can pass through the diffuser. The embodiment FIG. 6 shows the diffuser as employed with a plenum wherein neither a ceiling fan nor a light fixture is used -- that is, where the plenum and diffuser provide only for the passage of air.

FIG. 7 is a plan view of a damper as illustrated in FIG. 6.

FIG. 8 is a bottom view of the diffuser alone -- that is, wherein the diffuser is not shown in association with a plenum. Further, FIG. 8 shows the bottom view of the diffuser without the ancillary center shield or damper, as is referenced in FIGS. 6 and 7.

FIG. 9 is a cross-sectional view of the diffuser of this invention as taken along the line 9-9 of FIG. 8.

FIG. 10 is an elevational side view of the circular shield.

FIG. 11 is a bottom view of the diffuser showing the use of clips by which it can be held to cover an opening in a sheetrock ceiling.

FIG. 12 is a cross-sectional view of the diffuser, taken along the line 12-12 of FIG. 11 and showing how the clips are used to attach the diffuser to a sheetrock ceiling and plenum housing.

FIG. 13 is an isometric view of a clip for use with a diffuser showing in dotted outline how the clip is bent to hold the diffuser to an opening in a sheetrock ceiling and plenum housing.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

In the following table lists the number assigned to each important element illustrated in the drawings:

10	ceiling	68	hanger opening
12	first ceiling joist	70	hanger opening
14	second ceiling joist	72A-D	struts
16	opening	74	first rail
18	room	76	second rail
20	plenum housing	78	circumferential edge
20A	alternate plenum housing	80	central opening
22	electrical junction box	82	smudge frame
24	hanger	84	radial air slot openings
26	flange like collars	86	air deflecting fin
28	wood screw	88	lower edge
30	ceiling fan	90	upper edge
32	motor housing	92	inner integral hinge portion
34	hanger pipe	94	outer integral hinge portion
36	horizontal fan blades	96	circular shield
38	diffuser	98	damper/pattern shield
40	bezel	100	inner, semi-circular edge
42	horizontal bottom	102	outer, semi-circular edge
44	opening	104	legs
46	first end	106	slots
48	second end	108	legs
50	first sidewall	110	notches
52	second sidewall	112	circumferential recess
54	sloped top	114	metal clips
56	air inlet opening	116	short length portion
58	flange	118	longer length portion
60	flange	120	large diameter opening
62	cover plate	122	sheetrock
64	flexible conduit		
66	connector		

Referring to the drawings and first to FIG. 1, one environment in which the invention herein is practiced is illustrated. FIG. 1 shows a ceiling **10** formed by sheetrock that separates the interior of a room from an attic space as is typically provided in residential construction. Ceiling **10** is supported by ceiling joists **12** and **14**. The ceiling joists are typically spaced approximately 16-24 inches apart and are parallel to each other and horizontal, thereby support ceiling **10** in a horizontal position.

Formed in ceiling **10** is an opening **16** that is provided for the passage of air into the room **18**. Positioned above opening **16** is a plenum housing generally indicated by numeral **20**. The function of plenum housing **20** is to provide a means for attachment of a duct that is connected to a source of air used for heating, cooling and/or ventilating space **18**.

One feature of plenum housing **20**, as will be described in greater detail subsequently, is an electrical junction box **22**. In the arrangement of FIG. 1, junction box **22** is structurally supported by means of a hanger **24** that has at each end thereof, flange-like collars **26** that each has at the other end thereof a wood screw **28** by which the collars are secured to ceiling joists **12** and **14**.

In FIG. 1 there is shown supported to electrical junction box **22** a ceiling fan generally indicated by the numeral **30**. Ceiling fan **30** includes a motor housing **32** that is supported at the lower end of a hanger pipe **34**, the upper end of which is secured to junction box **22**. Extending from a lower end of motor **32** are a plurality of horizontal fan blades **36**. When the motor within housing **32** is energized, the fan blades are moved in a horizontal pattern to introduce turbulence into the air in room **18**.

Closing the opening **18** in ceiling **10** is a diffuser **38** that will be described in detail subsequently. The function of diffuser **38** is to provide passageway for air to flow from plenum

20 into room **18** and to assist in distribution of the air as it enters the room. Further, diffuser **38** provides an estatic covering for opening **16**.

As will be described subsequently, diffuser **38** has a central opening. Received on hanger pipe **34** is a decorative bezel that covers the central opening in diffuser **38**.

FIGS. 2 and 3 show more details of plenum housing **20**. The plenum has a horizontal bottom **42** having a large opening **44** that corresponds to the opening **16** in sheetrock **10** as seen in FIG. 1. Plenum housing **20** has a first vertical end **46** and a paralleled, opposed larger second vertical end **48**. Further, the plenum housing has first and second vertical sidewalls **50** and **52**. Sidewall **50** and **52** are equal-shaped trapezoids. A sloped top **54** completes the six-sided housing. Formed in slope top **54** is an air inlet opening **56** surrounded by a short length flange **58** that is configured to telescopically receive an air distribution duct (not shown in the drawings). Such distribution duct is typical of heating, ventilating and air conditioning systems by which air under pressure is delivered for distribution into the room **18** as seen in FIG. 1.

A short length flange **60** extends from large opening **44** in horizontal bottom **42**. Flange **60** is configured to extend through opening **16** in sheetrock ceiling **10.** Flange **60** is seen in FIGS. 1, 2 and 3.

Hanger **24** as shown in FIGS. 1 and 3 supports a fan and/or light and electrical junction box **22** to opposed ceiling joists, the ceiling joists not being shown in FIGS. 2 and 3. In FIG. 3, junction box **22** is shown with a cover plate **62** that is removed when a light fixture or a fan is supported to the junction box.

As seen in FIG. 3, a flexible conduit **64** extends from a connector **66** positioned in opening in second end **48** of plenum housing **20**, the flexible conduit **64** extending within the housing to junction box **22**. Conduit **64** serves as a means of passing electrical conductors from

exterior of the plenum housing to junction box **22** by which electrical energy is supplied to a light and/or ceiling fan.

Plenum housing **20** is installed in this manner: first, it is positioned between ceiling joists **12** and **14,** as seen in FIG. 1, with hanger **24** collapsed so that it is positionable between the ceiling joist and sheetrock installed after plenum is installed and with flange **60** extending within opening **16** in sheetrock **10**. Second, hanger **24** is then extended so that the screws **28** engage the surfaces of joists **12** and **14**. Third, the separate portions of hanger **24** are rotated to thread screws **28** into joists **12** and **14.** Plenum housing **20** is thus secured in position and junction box **22** is supported in a way that it can retain the weight of a light fixture or ceiling fan that is affixed to it.

Hanger **24** extends through small diameter openings **68** and **70** in sidewalls **50** and **52** respectively, such openings being shown only in FIG. 1.

FIGS. 4 and 5 show an alternate embodiment of the plenum housing, the alternate embodiment may be called a lay-in T-bar grid plenum, the alternate embodiment being designated as **20A.** This embodiment that is intended for use in a commercial building, office building, school or the like that does not employ wood ceiling joists as is shown in FIG. 1. Instead, in the embodiment of FIGS. 4 and 5, plenum housing **20A** is supported by four vertically depending struts **72A-72D.** The struts may be in the form, as illustrated, of elongated threaded bolts. Extending between pairs of struts **72A-72D** are opposed rails **74** and **76**. The rails are angle-shaped and the horizontal bottom **42** of the plenum housing **20A** rests on the rails **74** and **76**, or the rails can be positioned across the bottom of the plenum for a lay-in T-bar grid plenum.

In the embodiment of FIGS. 4 and 5, extendable hangers of the type shown in FIGS. 1 and 3, are not employed and instead, fixed hangers are used but generally speaking, all other aspects of the alternate plenum housing **20A** are the same as described for a plenum housing **20**.

An important feature of the invention is the provision of a diffuser **38** attached below ceiling **10** such as shown in FIG. 1, the diffuser being attached directly to the horizontal bottom of the plenum housing **20** or **20A** or to the sheetrock **10**. The diffuser **38** is shown in FIG. 1 but in greater detail in FIGS. 6, 8, 9, 11 and 12. FIGS. 8 and 9 show the improved diffuser alone. As seen in FIG. 8 the diffuser **38** is circular with an outer circumferential edge **78**. Concentrically positioned within the circumferential edge is a central opening **80** that is dimensioned to communicate with the bottom open end of a junction box such as the junction box **22** shown in FIG. 1.

Adjacent circumferential edge **78** is a circular integral forwardly or downwardly protruding smudge ring **82**. The element **82** is called a "smudge ring" since it serves to prevent direct radial passage of air coming out of the diffuser and to cause a slight downward inclination of the diffused air to thereby prevent the air from traveling along the interior surface of a ceiling, such as the surface of sheetrock **10** as shown in FIG. 1.

Radially extending from near central opening **80** to near smudge ring **82** are a plurality of air slot openings **84**. Twenty-four such air slot openings **84** being shown in FIG. 8. Air slot openings **84** are formed in a plate of rigid material of which the diffuser **38** is manufactured. As each air deflecting fin **86** is punched out an air slot opening **84** is formed. The material punched out to form openings **84** is not fully severed from the blank material of which the diffuser is made; instead, the material that is displaced to provide openings **84** remains integrally hinged to diffuser **38**. Each punched out and hinged air deflector fin **86** forms a radial slot opening **38.**

Each air deflector fin **86** is bent at a common angle to the plane of the diffuser. There is thereby one air deflecting fin **86** for each radial air slot opening **84**. Each air deflecting fin **86** has a radially extending longitudinal lower edge **88** and a radially extending longitudinal upper edge **90**. In this way, each of the air deflecting fins that is punched out has an inward integral hinged portion **92** that is adjacent to the central opening **80** and an outer integral hinge portion **94** that is adjacent to smudge ring **82**.

Thus, the diffuser is a generally planer, integral, circular structure formed of a sheet of rigid material and preferably a sheet of metal and having an uninterrupted circumferential outer edge and a central opening dimension to accommodate an electrical junction box, and having a plurality of radially extending partially punched-out fins that, after being punched out, are each bent to extend at a common angle to the plane of the structure, each bent fin providing a radially extending air slot opening. In addition, the circular structure is further defined by an inwardly formed concentric circular forwardly extending smudge ring that is circumferentially positioned between the fins and the circumferential outer edge.

The diffuser can be used in a variety of applications. For instance, if the diffuser is used to cover an opening in a ceiling, such as opening **16** in FIG. 1 in a situation where neither a ceiling light nor a ceiling fan is employed, then in that case, the use of an electrical junction box is not required, and the central opening **80** can be covered with a circular shield **96**. When the diffuser is used to accommodate a ceiling light fixture or a fan, the circular shield **96** is not employed. Further, as shown in FIGS. 6 and 7, a semi-circular damper/pattern shield **98**, can be secured to cover a portion of the radial air slot openings **84**. FIG. 7 shows a plan view of damper/pattern shield **98**. It is provided with an inner semi-circular edge **100** and has an outer semi-circular edge **102**. The diameter of inner semi-circular edge **100** is equal to or slightly

greater than the diameter of diffuser central opening **80**. The outer semi-circular edge **102** is of diameter less than the diameter of smudge ring **82** so that thereby the damper/pattern shield can fit at selected positions on the face of the diffuser **38** to reduce the total cross-sectional area through which air can escape and thereby reduce the quantity of air emanating from the diffuser. Damper/pattern shield **98** can be made to cover a few or many of the radial air slot openings **84**. Thus, damper/pattern shield **98,** in the embodiment of FIG. 6, reduces the air passageway through the damper in proportion to its size.

Circular shield **96** used to cover central opening **80** in the damper may be configured to provide for adjustable air flow. FIG. 10 shows an elevational view of an embodiment of circular shield **96** that has integrally formed legs **104**. At least three such legs **104** are required, however, in the embodiment shown, four such legs are shown, one of the legs being obscured. Each leg **104** has on its outer surface an increased thickness portion that has a horizontal slot **106** therein. This slot can be fitted into central opening **80** so that thereby the circular shield is supported at a distance spaced from the front surface of the diffuser providing a circumferential radial air passageway. In this way, the circular shield **96** visually covers opening **80** but at the same time allows the passage of air therethrough reducing velocity and noise.

The damper/pattern shield is removably attached to a diffuser by the provision of integral boss protrusions or legs **108**, each of which has a notch **110** that receives an edge of a diffuser slot opening **84**.

Diffuser **38** can be secured to a plenum housing, such as plenum housing **20**, by the use of screws or it may be mounted directly to a ceiling, also with screws. However, FIGS. 11, 12 and 13 illustrate a different way of affixing the diffuser to a ceiling formed of sheetrock or similar material. FIG. 11 shows the bottom view of diffuser **38** and shows a circumferential

recess **112** that exists as a result of forming smudge frame **82** as seen in FIGS. 6, 8 and 9. Positioned within circumferential recess **112** is a plurality (three being shown) of metal clips **114**. FIG. 13 is an isometric of a clip **114** showing the clip in its ready-to-use or manufactured state and in dotted outline - the shape the clip takes after it has been used. Clip **114** has a short length inner end portion **116** with a threaded bolt hole therein. This short length portion **116** is received in circumferential groove **112**. A longer length outer end portion **118** extends perpendicular to a plane of diffuser **38** through opening **44** in plenum housing **20** to permit the diffuser with a plurality of clips to be positioned to cover a large diameter opening **120** in sheetrock **122** or other similar ceiling material. After clips **114** are positioned the longer length portion **118** of each clip is bent to overlie the inner surface of the horizontal bottom **42** of plenum housing **20** as shown in dotted outline in FIG. 12. If a junction box is not in place workman can bend the clip longer length portions **118** by extending a hand through diffuser central opening **120**. A diffuser **38** can be mounted or removed by threading or unthreading bolts that pass through holes in the diffuser and engage threaded openings in the short length inner end portions **116** of clips **114**.

The unique plenum housing and diffuser provide a simplified yet efficient way of installing an outlet opening of a HVAC system communicating into a room in a way to allow the plenum housing to be used for air distribution alone, for air distribution in combination with a light fixture, or air distribution in combination with a ceiling fan. It is common to attach a light fixture to the bottom of a ceiling fan. The innovative plenum housing and diffuser reduced clutter in the ceiling of a building and especially in the ceiling of a house so that one opening in a ceiling can serve to permit the distribution of air for heating, cooling and/or ventilation. Further, the same opening is used for a light fixture or a ceiling fan.

While the invention has been described with a certain degree of particularity, it is manifest that many changes may be made in the details of construction and the arrangement of components without departing from the spirit and scope of this disclosure. It is understood that the invention is not limited to the embodiments set forth herein for purposes of exemplification, but is to be limited only by the scope of the attached claims, including the full range of equivalency to which each element thereof is entitled.